PATENT SPECIFICATION 769,106

Date of filing Complete Specification : July 12, 1955.

Application Date : Aug. 26, 1954. No. 24868/54.

Complete Specification Published : Feb. 27, 1957.

Index at Acceptance :—Class 86, C(8 : 19E).

International Classification :—B01f. E02g.

COMPLETE SPECIFICATION.

Improvements in and relating to Mixing Machines.

I, HORACE FRITZ BEKEN, a British Subject, of 39 Tawney Avenue, Upminster, Essex, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to mixing machines, and more especially to mixing machines adapted for continuous operation rather than for batch operation.

The invention consists in a mixing machine comprising a container housing two shafts provided with blades of helical or worm-like form, each blade having at least one concave surface, and the shafts being located so that as they are rotated their respective blades intermesh and thereby agitate material e.g. by repeated compression and extension between them, means for rotating the shafts at differential speeds, an inlet for feeding materials into the container, and an outlet for mixed materials from the container, remote from said inlet, to which outlet the materials are impelled by said blades during the mixing operation. The term "blades" used herein includes any projections from the shafts suitable for effecting the mixing operation, and in view of their substantially continuous helical or worm-like form these projections have the character of a screw-thread of coarse pitch.

In one convenient form of the invention materials which it is desired to mix together in a suitable container, are worked together by a pair of continuous worm devices carried on two preferably parallel shafts located in the container closely adjacent to one another, so that the worms deeply intermesh with one another, the worms being driven in opposite senses, and one worm rotating about its axis at twice the speed of rotation of the other worm. Having regard to this relationship of speeds of rotation, the worms will hereinafter be referred to respectively as the slow worm and the fast worm. In order that the worms may rotate continuously without jamming or interfering with one another, the pitches of the worms are of selected prearranged values, e.g. the slow worm may be of relatively coarse pitch, and the fast worm of relatively fine pitch, in the ratio of approximately 2 : 1. The worms are preferably horizontal, and preferably extend over the full internal length of the container, which is selected to accommodate a slow worm, i.e. the coarser pitched worm, having a total angular twist or turn along its full length determined by the rate at which it is desired to impel materials through the machine for any given speed of rotation of the slow worm, while the faster worm has a correspondingly angular twist or turn along its full length. In typical forms of the invention the slow worm may have a total angular twist or turn along its full length of 180°—270°, the faster worm having a correspondingly greater angular twist or turn, e.g. 360°—540°, but it is within the scope of the invention to employ worms of less or greater angular twists along their full lengths than the aforesaid values. The radii of the worms are selected, having regard to the spacing of the worm shafts, to ensure that during rotation the edge of each worm passes very close to the hub of the other worm, and the casing is preferably in the form of two adjacent part-cylindical compartments, each accommodating one worm and of such radius that the worm moves closely adjacent to the wall of its compartment. Means may be provided for feeding the materials to be mixed into one end of the container, and for letting out the mixed materials at the other end of the container (to which the materials are

advanced, during mixing, by the worms).

The principle of using closely intermeshing helical or partially worm-shaped blades or paddles for the batch mixing of materials is known from British Patent Specification No. 440,794 and the important features of the present invention may, perhaps, be more readily comprehended by contrast with the mixing machine described therein. From consideration of Specification No. 440,794 it will be seen that in the machine there described each of the rotors comprises a plurality of blades or paddles secured in relatively spaced positions on a common shaft, the blades or paddles on one shaft being curved and relatively positioned to lie along a helix, while the blades or paddles on the outer shaft are in two pairs, each pair being arranged in relative helical positions, but a gap or discontinuity in the helical arrangement occurring between the two pairs. It will also be noted that the casing and shafts are of comparatively short length so that the relative angular disposition of the end blades of each shaft is only of small value, e.g. about 90° or less.

It will be seen, therefore that the machine described in Specification No. 440,794, while suitable for batch mixing of some materials, is unsuited for continuous mixing, since the length, pitch and blade-separation of the machine described all militate against the effective longitudinal propulsion of the materials during mixing which is necessary for continuous operation.

In contrast, the use, in a mixing machine according to the present invention, of worms which are unbroken and continuous from end to end, and are of substantial length so that, having regard to the pitch and throw of the worms selected, the time required to propel the materials longitudinally from infeed to outlet can be predetermined, ensures effective mixing while allowing continuous working of the machine.

The invention will be clearly understood from the following description of one form (given, however, merely by way of example) which it may assume and this description will be more readily followed by reference to the drawings accompanying the Provisional Specification of this invention herewith, wherein :—

Figure 1 represents a side view; and

Figure 2 a plan view (partly in section) of a mixing machine according to the invention;

Figure 3 represents a sectional end elevation along the line III—III of Figure 1; and

Figure 4A, B, C, D represent diagrammatically relative positions of the worms shown in Figure 3, with the faster worm in selected angular positions during one complete rotation.

In carrying the invention into effect in one convenient manner, as shown in the aforesaid drawings, a mixing machine comprises a trough, pan or like container 1, carried by end-supports 2, and housing two parallel shafts 3, 4 rotatable in suitable bearings 5 in the supports 2, and interconnected at one (or at each) end by gear wheels 6, 7. On the shafts 3, 4 are formed or secured worms 8, 9 which extend unbroken substantially from end to end of the container.

The bottom and sides of the container 1 are shaped to two radii about the axes of shafts 3, 4, so that two adjoining compartments, each part of a cylinder, are formed, and the radii of these compartments are approximately equal to the radii of the worms, 8, 9 respectively accommodated in them, so that the edges of the worms, in rotation move very closely to the container walls. The spacing of the shafts 3, 4 is selected, having regard to the radii of the worm hubs, to ensure that the edge of each worm in rotation passes the hub of the other worm with very close tolerance. The dimensions, cross sectional shape, and pitch of each worm are selected to ensure that during rotation the edges of each worm traverses closely a co-operating face of the opposing worm, and that in other relative angular positions of the worms, co-operating faces of the two worms approach closely together to press the materials together between them.

In order that the two worms 8, 9 may run continuously without jamming together, the pitches of the worms are duly selected having regard to the ratio of the gears 6, 7. Preferably the gear ratio is 2:1, and in this case the slower worm 9 is of relatively coarse pitch, and the faster worm 8 of relatively fine pitch, approximately in the artio 2:1 (Figure 2). It will be apparent that being directly geared together the shafts, 3, 4 when driven (e.g. by driving shaft 10 connected to the shaft 3 of the fast worm 8) rotate in opposite senses, and they are preferably driven so that the edges of the worm move inwards from the sides of the container 1, and downwards along the median plane of the container 1.

It should, perhaps, be remarked that the cross-sectional shapes of the worms (Figure 3) is most easily settled empirically (e.g. by experiment with two-dimensional models on a drawing-board), after other factors have been settled, e.g. trough dimensions, shaft and worn radii etc., since those shapes depend upon variables which appear not to permit of calculation of any general formula for the various shapes suitable for all possible values of the other variables which may be selected or predetermined by other considerations. The shapes illustrated in

Figure 3 are appropriate for worms relatively spaced, and mounted upon shafts, as shown, in a trough also of the dimensions there shown, and of relative pitches and interconnecting gearing shown in Figure 2. The worms comprise blades each having at least one concave surface. As shown the blades of one (the faster) worm 8 have each a concave leading face, and a convex trailing face, while the blades of the other (slower) worm 9 are each concave on both faces. The relative angular positions of the worms for selected angular positions of the faster worm 8, are shown in Figure 3 and 4A, B, C & D. The worms, rotating in the senses indicated by the arrows, move from, say positions shown in Figure 3 to that shown in Figure 4A where one edge *x* of the fast worm 8 is about to traverse the front face of slow worm 9. The edge *x* of worm 8 proceeds through the positions shown in Figures 4A & 4B to that of Figure 4C where the front face of the opposite blade *y* of worm 8 closes in towards the rear of the blade of worm 9, compressing the material therein. The tip *y* of worm 8 then traverses the rear face of blade *x* of worm 9, thereafter reverting to the position shown in Figure 3 save that the opposite blade of worm 9 is now uppermost.

At one end the trough 1 is provided with means, such as a hopper 11, for feeding in materials to be mixed, while at the other end the trough is provided with means, e.g. an outlet 12 (which may, if desired, be fitted with a releasable closure), for removal or escape of mixed materials from the machine.

It will be seen that materials fed into the machine at one end are propelled towards the other end by the worms which, in so doing, mix the materials together very effectively in the manner described above. The operation proceeds continuously since fresh material can be fed in by hopper 11 at the same rate as mixed materials are ejected by the worms from the outlet 12.

In modified forms of the above described mixing machine according to the invention, the edges of either, or each, worm may be of wave- or serrated-form, and/or the blades of the worms may be formed with apertures, or be of grid-like structure, to allow passage of some of the material during mixing, the material being thus "drawn out". These modifications reduce the pressure of the worms on the material. Alternatively or in addition one, or each, of the worms may be tapered from one end of its shaft to the other, and in this case the shafts are preferably inclined to one another in order to ensure deep intermeshing of the worms along their full lengths. While the shafts are preferably horizontal, and side by side, it is within the scope of the invention to have them inclined to the horizontal and/or located one above the other. The trough 1 may, if desired be provided with a removable cover, preferably of intersecting arcuate cross-section (similar to the lower part of the trough as shown in Figure 3) in order to fit closely over the rotating worms. If desired the trough 1 may be double-walled in order to allow heating, e.g. by steam, or cooling, e.g. by water, and/or fitted with other means for heating the materials under treatment.

While the machine described above incorporates worms interconnected by gearing of 2:1 ratio and of suitable pitch and dimensions to ensure non-jamming, it should be understood that worms of other pitches and dimensions may be utilised, and interconnected by gears of other ratios, without departing from the scope of the invention.

From the above description it will be seen that the invention provides an effective mixing machine suitable for mixing together a wide variety of materials, and especially useful for continuous operation. It should, however, be understood that the invention is not restricted solely to the details of the forms described above, which may be modified in order to meet various conditions and requirements encountered, without departing in any way from the scope of the invention.

What I claim is :—

1. A mixing machine comprising a container housing two shafts provided with blades of helical or worm-like form, each blade having at least one concave surface, and the shafts being located so that as they are rotated their respective blades intermesh and thereby agitate material e.g. by repeated compression and extension, between them, means for rotating the shafts at differential speeds, an inlet for feeding materials into the container and an outlet for mixed materials from the container, remote from said inlet, to which outlet the materials are impelled by said blades during the mixing operation.

2. A mixing machine as claimed in Claim 1 wherein the blades on the two shafts are of different pitches.

3. A mixing machine as claimed in Claim 1 or 2 wherein the pitches of the two blades are approximately in the ratio 2:1.

4. A mixing machine according to Claim 1, 2 or 3 wherein the coarser pitched blade is twisted through an angle along its full length such that for given speed of rotation of the shaft a predetermined, and preferably substantial, time is required to propel material through the container.

5. A mixing machine as claimed in any preceding claim wherein the two bladed shafts are parallel to one another.

6. A mixing machine as claimed in any preceding claim comprising means for rotating the shafts at speed in the ratio of 2:1.

7. A mixing machine as claimed in any preceding claim wherein each blade on one of the shafts has a concave surface on one side and a convex surface on the other side.

8. A mixing machine as claimed in Claim 7 wherein the shaft carrying the said concavo-convex blades is rotated in such a sense that the concave surface of each blade is the leading surface as the blade is rotated.

9. A mixing machine as claimed in any preceding claim wherein each blade on one of the shafts has a concave surface on each side.

10. A mixing machine as claimed in Claim 9 wherein the shaft carrying the concavo-concave blades is rotated more slowly than the other shaft.

11. A mixing machine as claimed in any preceding claim wherein the two shafts are rotated in such senses that the blade tips of the two shafts move towards one another when sweeping nearest to the materials inlet of the container.

12. A mixing machine as claimed in any preceding claim wherein the container is tunnel shaped and has an inlet adjacent to one end and an outlet adjacent to the other end.

13. A mixing machine as claimed in any preceding claim wherein the container comprises two conjoined part-cylinders each housing one of the bladed shafts, and of such diameter that the blades extend and rotate close to the inner surfaces thereof.

14. A continuously operable mixing machine substantially as described herein with reference to the drawings accompanying the Provisional Specification herewith.

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PROVISIONAL SPECIFICATION.

Improvements in and relating to Mixing Machines.

I, HORACE FRITZ BEKEN, a British Subject, of 39 Tawney Avenue, Upminster, Essex, do hereby declare this invention to be described in the following statement :—

This invention relates to mixing machines, and more especially to mixing machines adapted for continuous operation rather than for batch operation.

According to the invention materials which it is desired to mix together in a suitable container, are worked together by a pair of continuous worm devices carried on two preferably parallel shafts located in the container closely adjacent to one another, so that the worms deeply intermesh with one another, the worms being driven in opposite senses, and one worm rotating about its axis at twice the speed of rotation of the other worm. Having regard to this relationship of speeds of rotation, the worms will hereinafter be referred to respectively as the slow worm and the fast worm. In order that the worms may rotate continuously without jamming or interfering with one another, the pitches of the worms are of selected prearranged values, e.g. the slow worm may be of relatively coarse pitch, and the fast worm of relatively fine pitch, in the ratio of approximately 2:1. The worms are preferably horizontal, and preferably extend over the full internal length of the container, which is selected to accommodate a slow worm, i.e. the coarser pitched worm, having at least 180° of twist or turn along its full length (and preferbly a greater turn, e.g. 270°), while the faster worm has a correspondingly greater turn, e.g. 360° or 540° respectively. The radii of the worms are selected, having regard to the spacing of the worm shafts, to ensure that during rotation the edge of each worm passes very close to the hub of the other worm, and the casing is preferably in the form of two adjacent part-cylindrical compartments, each accommodating one worm and of such radius that the worm moves closely adjacent to the wall of its compartment. Means may be provided for feeding the materials to be mixed into one end of the container, and for letting out the mixed materials at the other end of the container (to which the materials are advanced, during mixing, by the worms).

The principle of using closely intermeshing helical or partially worm-shaped blades or paddles for the batch mixing of materials is known from British Patent Specification No. 440,794, and the important features of the present invention may, perhaps be more readily comprehended by contrast with the mixing machine described therein. From consideration of Specification No. 440,794 it will be seen that in the machine there described each of the rotors comprises a plurality of blades secured in relatively spaced positions on a common shaft, the blades or paddles on one shaft

being curved and relatively positioned to lie along a helix, while the blades or paddles on the other shaft are in two pairs, each pair being arranged in relative helical positions but a gap or discontinuity in the helical arrangement occurring between the two pairs. It will also be noted that the casing and shafts are of comparatively short length so that the relative angular disposition of the end blades of each shaft is only about 90° or less.

It will be seen, therefore that the machine described in Specification No.440,794, while suitable for batch mixing of some materials, is unsuited for continuous mixing, since the length, pitch and blade-separation of the machine described all militate against the effective longitudinal propulsion of the materials during mixing which is necessary for continuous operation.

In contrast, the use in mixing machine according to the present invention, of worms which are unbroken and continuous from end to end, and are of substantial length so that the worm of coarser pitch has a throw of at least 180° ensures both effective mixing of the materials and the longitudinal propulsion from infeed to outlet which is required for continuous working.

The invention will be clearly understood from the following description of one form (given, however, merely by way of example) which it may assume, and this description will be more readily followed by reference to the accompanying drawings, wherein:—

Figure 1 represents a side view; and

Figure 2 a plan view (partly in section) of a mixing machine according to the invention;

Figure 3 represents a sectional end elevation along the line III—III of Figure 2; and

Figure 4A, B, C, D represent diagrammatically relative positions of the worms shown in Figure 3, with the faster worm in selected angular positions during one complete rotation.

In carrying the invention into effect in one convenient manner as shown in the drawings herewith, a mixing machine comprises a trough, pan or like container 1, carried by end-supports 2, and housing two parallel shafts 3, 4 rotatable in suitable bearings 5 in the supports 2, and interconnected at one (or at each) end by gear wheels 6, 7. On the shafts 3, 4 are formed or secured worms 8, 9 which extend unbroken substantially from end to end of the container.

The bottom and sides of the container 1 are shaped to two radii about the axes of shafts 3, 4, so that two adjoining compartments, each part of a cylinder, are formed, and the radii of these compartments are approximately equal to the radii of the worms 8, 9 respectively accommodated in them, so that the edges of the worms, in rotation move very closely to the container walls. The spacing of the shafts 3, 4 is selected, having regard to the radii of the worm hubs, to ensure that the edge of each worm in rotation passes the hub of the other worm with very close tolerance. The dimensions, cross sectional shape, and pitch of each worm are selected to ensure that during rotation the edges of each worm traverses closely a co-operating face of the opposing worm, and that in other relative angular positions of the worms, co-operating faces of the two worms approach closely together to press the materials together between them.

In order that the two worms 8, 9 may run continuously without jamming together, the pitches of the worms are duly selected having regard to the ratio of the gears 6, 7. Preferably the gear ratio is 2:1, and in this case the slower worm 9 is of relatively coarse pitch, and the faster worm 8 of relatively fine pitch, approximately in the ratio 2:1 (Fig. 2). It will be apparent that being directly geared together the shafts, 3,4 when driven (e.g. by driving shaft 10 connected to the shaft 3 of the fast worm 8) rotate in opposite senses, and they are preferably driven so that the edges of the worms move inwards from the sides of the container 1, and downwards along the median plane of the container 1.

It should, perhaps, be remarked that the cross-sectional shapes of the worms (Figure 3) is most easily settled empirically (e.g. by experiment with two-dimensional models on a drawing board), after other factors have been settled, e.g. trough dimensions, shaft and worm radii etc., since those shapes depend upon variables which appear not to permit of calculation of any general formula for the various shapes suitable for all possible values of the other variables which may be selected or predetermined by other considerations. The shapes illustrated in Figure 3 are appropriate for worms relatively spaced, and mounted upon shafts, as shown, in a trough also of the dimensions there shown, and of relative pitches and interconnecting gearing shown in Figure 2. The relative angular positions of the worms for selected angular positions of the faster worm 8, are shown in Figures 3 and 4A, B, C & D. The worms, rotating in the senses indicated by the arrows, move from, say positions shown in Figure 3 to those shown in Figure 4A where one edge x of the fast worm 8 is about to traverse a face of slow worm 9. The edge x of worm proceeds through the positions shown in Figures 4A & 4B to that of Figure 4C where the front face of the opposite blade y of worm 8 closes in towards the rear of

the blade of worm 9, compressing the material therein. The tip *y* of worm 8 then traverses the rear face of blade *x* of worm 9, thereafter reverting to the position shown in Figure 3 save that the opposite blade of worm 9 is now uppermost.

At one end the trough 1 is provided with means, such as a hopper 11, for feeding in materials to be mixed, while at the other end the trough is provided with means, e.g. an outlet 12 (which may, if required, be fitted with a releasable closure), for removal or escape of mixed materials from the machine.

It will be seen that materials fed into the machine at one end are propelled towards the other end by the worms which, in so doing, mix the materials together very effectively in the manner described above. The operation proceeds continuously since fresh material can be fed in by hopper 11 at the same rate as mixed materials are ejected by the worms from outlet 12.

In modified forms of the above described mixing machine according to the invention, the edges of either, or each, worm may be of wave- or serrated-form, and/or the blades of the worms may be formed with apertures, or be of grid-like structure, to allow passage of some of the material during mixing, the material being thus "drawn out." These modifications reduce the pressure of the worms on the material. Alternatively or in addition one, or each, of the worms may be tapered from one end of its shaft to the other, and in this case the shafts are preferably inclined to one another in order to ensure deep intermeshing of the worms along their full lengths. While the shafts are preferably horizontal, and side by side, it is within the scope of the invention to have them inclined to the horizontal and/or located one above the other. The trough 1 may, if desired be provided with a removable cover, preferably of intersecting arcuate cross-section (similar to the lower part of the trough as shown in Figure 3) in order to fit closely over the rotating worms. If desired the trough 1 may be double-walled in order to allow steam-heating, and/or fitted with other means for heating the materials under treatment.

While the machine described above incorporates worms interconnected by gearing of 2:1 ratio and of suitable pitch and dimensions to ensure non-jamming, it should be understood that worms of other pitches and dimensions may be utilised, and interconnected by gears of other ratios, without departing from the scope of the invention.

From the above description it will be seen that the invention provides an effective mixing machine suitable for mixing together a wide variety of materials, and especially useful for continuous operation. It should, however, be understood that the invention is not restricted solely to the details of the forms described above, which may be modified in order to meet various conditions and requirements encountered, without departing in any way from the scope of the invention.

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Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1957.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2,
from which copies may be obtained.

Fig. 1.

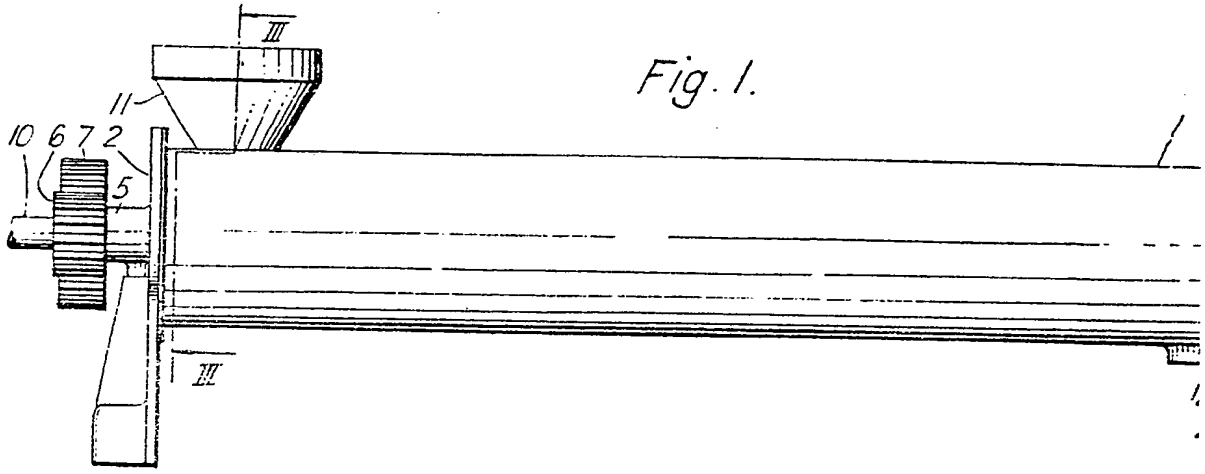
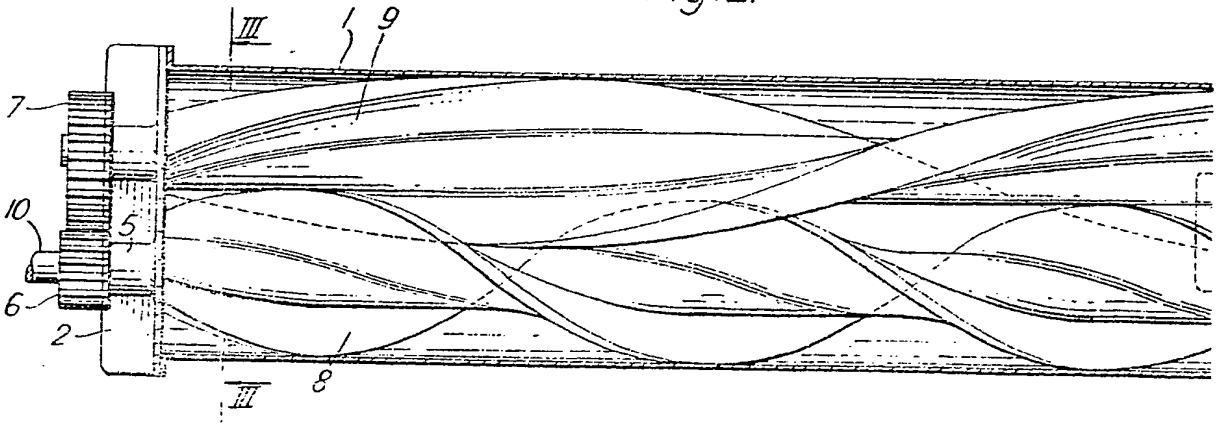


Fig. 2.



769,106 PROVISIONAL SPECIFICATION

1 SHEET

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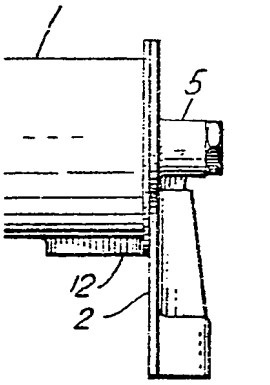


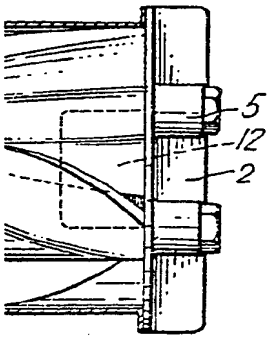


Fig. 3.

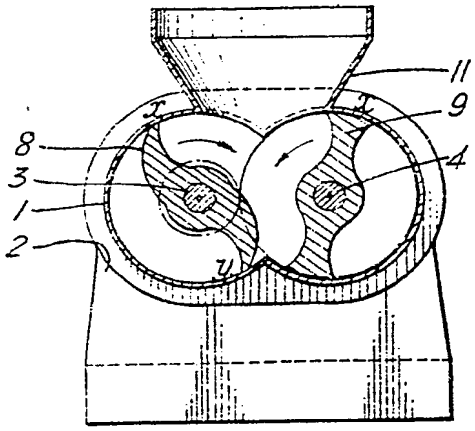
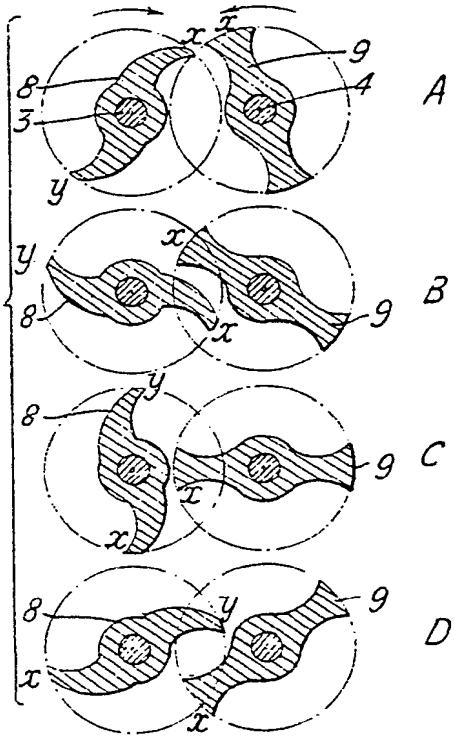


Fig. 4.



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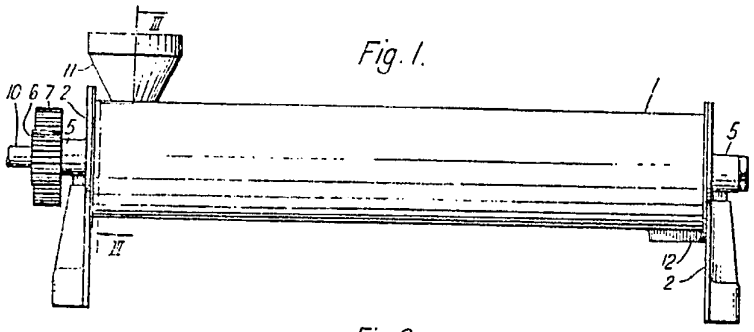

Fig. 2.

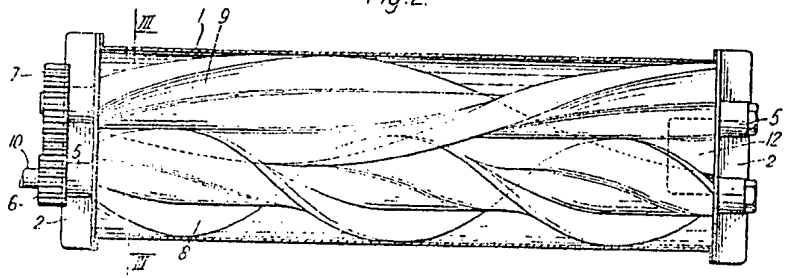

Fig. 3.

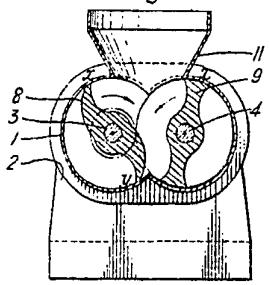

Fig. 4